PESTICIDES IN ZIMBABWE

Toxicity and Health Implications

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11
Metabolism of Pesticides

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Summary

The metabolism of pesticides, like that of many other chemicals, takes place mainly in the liver, skin, gastrointestinal tract, kidneys and lungs. These organs have the capacity to bring about enzymatic reactions of metabolism. In this chapter, metabolism of pesticides is exemplified by the metabolic pathways of the organochlorine, DDT, and the organophosphate, parathion.

Metabolism means more than just one thing. On one hand, the chemical and enzymatic reactions and processes that maintain the existence of any organism may be referred to as metabolism. On the other hand, metabolism may mean the conversion or transformation of chemical substances foreign and endogenous to an organism by chemical or enzymatic reactions in the organism. "Foreign compounds" refers to non-nutrient substances to a specific organism.

Pesticides may enter the body by way of ingestion in food or drink, inhalation, through the eyes or by absorption through the skin (Neal, 1975).

The metabolism of pesticides, that is, the total fate of pesticides in the body, including their absorption, distribution, biotransformation and excretion like that of other foreign substances is handled in the body by certain organs. Although the liver is perhaps the major organ involved in metabolism of chemicals, the kidney, skin, the gastrointestinal tract (GIT) and the lungs are all involved in metabolism too (Briggs and Briggs, 1974). A more detailed account of the mechanisms of metabolism is presented by Williams (1959) and La du *et al.* (1971).

Briefly, the metabolism of foreign as well as endogenous compounds is effected by a group of complex and multifunctional enzymes which are synthesized in the endoplasmic reticulum of most organs with metabolic capacity. In these organs, metabolism of substances proceeds through two phases. Phase I which consists of such reactions as oxidation, reduction and hydrolysis. Phase II reactions consist of conjugation and/or synthesis. Generally, phase I reactions produce derivatives of compounds that undergo phase II reactions. The enzymes responsible for phase I reactions are referred to collectively as the cytochrome P_{450} (cyt P_{450}) or the mixed function oxidases and phase II enzymes are the conjugation or synthetic enzymes. Products of phases I and II products can be more (or less) toxic than the parent compound. Thus, the concept of detoxication does not depend on the phases but on the nature

(chemistry) of particular compounds. This, in fact, is so with a number of pesticides, particularly the organophosphates (Neal, 1975).

There are so many different types of pesticides utilised in Zimbabwe and a detailed account of the manner in which the different types of insecticides are metabolised is beyond the scope of this book. However, two pesticides, DDT, dichlorodiphenyl trichloroethane – an organochlorine and parathion – an organophosphate, are illustrated as examples of how pesticides are metabolised in the human body.

DDT has been used in Zimbabwe as a vector control agent against the mosquito and tsetse fly. DDT is metabolised through two main pathways. One pathway leads to production of the corresponding dichloro-ethylene – dichlorodiphenyldichloroethylene (DDE), and the dechlorinated and oxidation product – dichlorodiphenyldichloroethane (DDD). The second pathway is the production of the carboxylic acid – dichlorodiphenyl acetic acid (DDA), as shown in Figure I below.

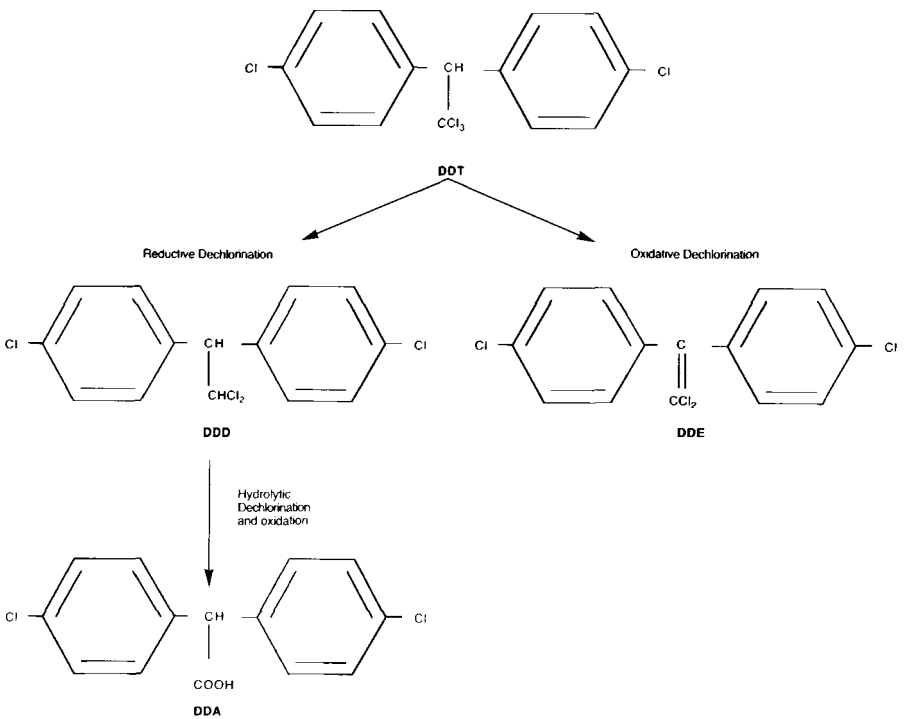

Figure 1: Metabolism of DDT

All these metabolites may be toxic to the human body. These metabolites are excreted through the urine although the parent compound, DDT, is also excreted in breast milk.

Organophosphate insecticides are widely used in Zimbabwe in the agricultural sector against pests, for instance, in cotton and coffee production. Parathion – an organophosphate, is used quite heavily on coffee plantations. In the body, parathion is converted to the toxic product – paraoxon, by a process of isomerisation. The paraoxon so produced is further converted by metabolic enzymes to p-nitrophenol, diethyl phosphate and p-aminophenol which are excreted in urine (Figure2).

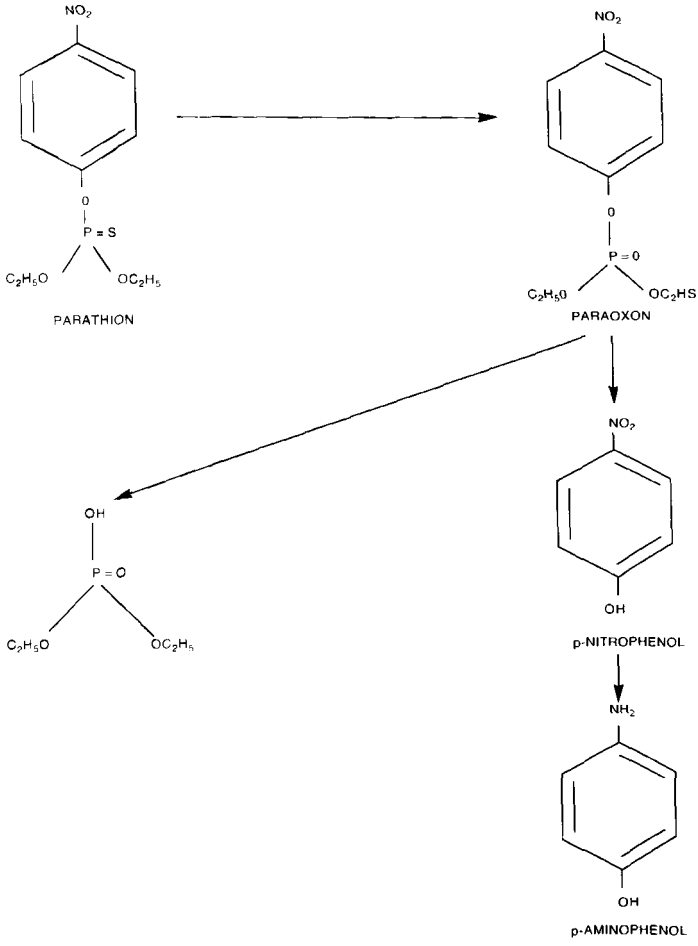

Figure 2: Metabolism of Parathion

Thus, the toxicity of parathion is related to its conversion to paraoxon. Metabolised and unmetabolised pesticides are eventually excreted through the urine, bile, faeces, perspiration, vomitus, milk, hair or expired air.

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